SYNOPSIS V1.0:

Heavy Ion Latch-up and Transient Test Results for the Texas Instruments OPA2347 Operational Amplifier

Ray Ladbury[1] and Hak Kim[2]

1. Orbital Sciences Corp.
2. Jackson and Tull Chartered Engineers

TEST DATE: October 2-3, 2002 REPORT DATE: October 7, 2002

I. INTRODUCTION

This study was undertaken to determine the heavy-ion induced single-event latch-up (SEL) and single-event transient (SET) sensitivities of the Texas Instruments (TI) OPA2347 instrumentation amplifier. The testing was done at the Texas A&M University Cyclotron Institute in College Station, TX. The power supply current was monitored for large increase, and the device's functionality was verified after each single event latchup (SEL). Transients were counted and recorded for later study.

II. DEVICES TESTED

The OPA2347 is a single-supply, rail-to-rail instrumentation amplifier fabricated in TI's (formerly Burr-Brown's) BiCMOS process.

Three samples of the device were tested. No clear lot date codes were evident, although the packages bore markings 26zzz.

III. TEST FACILITY

Facility: Texas A&M University Cyclotron Institute.
Flux Range: $5x10^3$ to $3x10^5$ particles/cm^2/s.
Particles: linear energy transfer (LET)

Ion	LET ($MeVcm^2/mg$)
Ar	8.45
Cu	19.95
Ag	42.85

IV. TEST METHODS

Temperature: ambient and elevated temperature (~80-85 degrees C)

Test Hardware: An VXI-based custom test set was used to supply nominal input levels to the DUTs and monitor the bias supply current for changes resulting from the radiation exposure. Files were generated for each DUT to track changes the supply current with a measurement accuracy of 100 pA. The current was measured and recorded at 10 ms intervals throughout the exposure. An oscilloscope was used to monitor DUT functionality and count and capture transients during the irradiation.

Software: Customized LABVIEW® software provided a user interface to control signals to the DUT. The software also automatically monitored supply currents and generated a file history. In the event that the supply current exceeded a predefined value, called the limiting current (I_L), the software automatically turned off the DUT power supply.

Test Techniques: Tests were performed to screen for susceptibility to latch-up and measure latch-up sensitivity as a function of particle LET. A secondary goal was to determine the susceptibility of the OPA2347 to transients. The devices were tested at their application voltage (V_{cc} = 3.6 V) and at both ambient and elevated temperature. An equivalent normal-incidence fluence of at least $1x10^7$ ions/cm^2 was used at each test condition unless an SEL occurred. A beam flux range of $5x10^3$ to $3x10^5$ particles/cm^2/s resulted in individual exposures between 33 seconds and 10 minutes.

Device functionality was monitored by varying the input to the chip and verifying that the output also changed. If the device current experienced a sudden increase larger than I_L, the power was cycled and the DUT was checked for functionality; we called this an SEL. The DUT functionality information was not saved to a file, but was recorded in the run log.

V. RESULTS

The OPA2347 did exhibit SEL for effective LETs as low as 11.95 MeVcm^2/mg with limiting cross sections on the order of 2E-4 cm^2. Effective LETs were obtained by varying the angle of incidence of the particle beam relative to the die surface's normal. This allows testing at LET values other those given in the table in section III.

The device also exhibited transients with magnitudes up to the rail and durations of up to 10 μs. These transients could pose concerns for some applications.

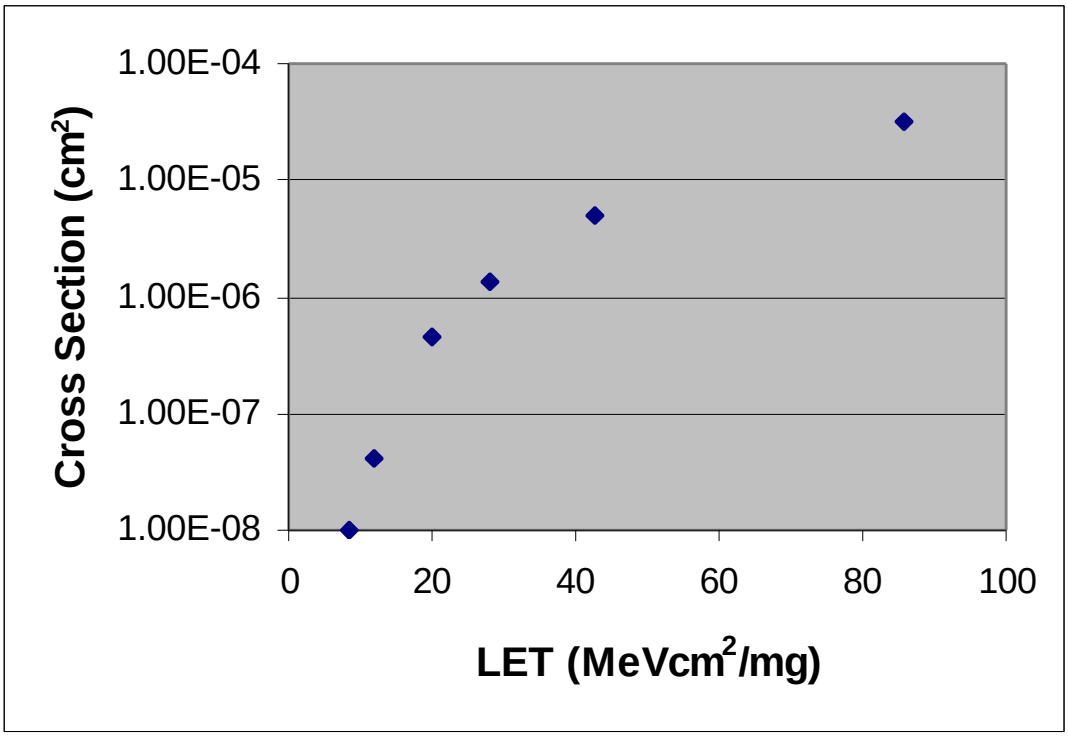

Figure 1 SEL Cross Section vs. LET

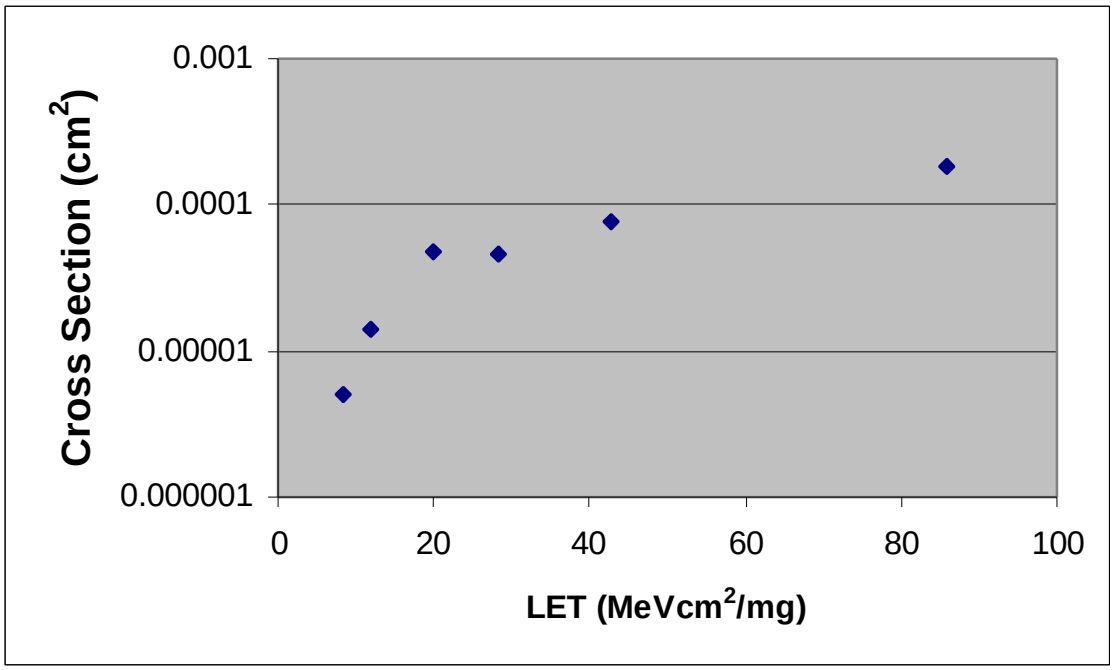

Figure 2 Transient Cross Section vs. LET

Due to lack of time, the LET threshold for transients could not be determined. However, it is likely that given the slow drop off of the cross section vs. LET curve, the threshold will be about 1 MeVcm^2/mg.

VI. COMMENTS AND RECOMMENDATIONS

In general, the REA group does not recommend the use of devices in space flight applications that experience an SEL at an LET less than or equal to 37 MeV cm^2 / mg. Significant error mitigation approaches capable of detecting an increase in current and responding to rapidly cycle power would be required if these devices are used in a space flight application. The extent of degradation of device lifetime and reliability due to an SEL can be significant.

Given that the OPA2347 exhibited SELs well below this level, caution is advised in any application considering this part. The part was also susceptible to single-event transients (SETs). Past testing has shown that the transient response of linear devices can be quite dependent on application conditions. If SETs are a concern, additional testing may be necessary.